Examination of the Potential for Reuse of Chromated Copper Arsenate Wood Waste by Nitric Acid Pulping

by

Connell Wood

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Abstract

Treated timber is a widely used construction material, as it is resistant to insect and fungal attack. The most commonly used timber treatment solution worldwide is copper chromium arsenate (CCA) pressure treated wood (APVMA 2005a). Environmental and health issues have been raised over CCA wood, with major particular concern raised on the possibilities of arsenic in the wood potentially leaching out. The Australian Pesticides and Veterinary Medicines Authority (APVMA) have limited its usage to minimise human contact with CCA structures (APVMA 2005a). In South Australia, CCA applications increased dramatically with the expansion of the winery industry where CCA treated timber posts were widely used for vineyard trellises. Due to the mechanical method by which most grapes are harvested, roughly 2% of all posts are broken and require disposal annually (SAEPA 2008). The Environmental Protection Agency of South Australia (EPASA) have placed restrictions on CCA disposal from vineyards (SAEPA 2004) and waste CCA stock is either stockpiled or sent to specially lined landfills incurring an estimated cost penalty of over $AU 200 per tonne[1]. Clearly, improved CCA treatment technologies must be developed to reduce (or eliminate) the cost of CCA disposal and to the footprint of land filled waste.

CCA timber disposal techniques currently being researched are focussed primarily on thermal and biological routes. Thermal techniques are problematic due to volatilization of the arsenic in the product, whilst biological removal techniques are very slow. Chemical remediation is an alternative and attractive disposal technique of interest using various acids to extract copper, chromium and arsenic. Nitric acid has been shown to be particularly effective (Honda, Kanjo et al. 1991), although research has been limited. Nitric acid is also used in one method of paper pulp production, and as such, there is the potential for a combined CCA extraction and paper pulp process. This has the attraction of turning a waste in a value added product

The kinetics of copper, chromium and arsenic dissolution in nitric acid has been examined in this thesis. A key finding of the work identifies the size of CCA wood particles as the dominant factor affecting the extraction rate, whilst temperature and acid concentration only provide a minor effect. The extraction rate for all elements from CCA wood using nitric acid generally follow 2nd order kinetics. Concurrently, a study examining wood chips of various ages taken from vineyards was performed using chip sizes typical required for paper production. It was found that despite significant variations in the concentration profile of CCA in posts, a general model based on the fraction of each element

[1]Personal communication with John Blumson, Zero Waste South Australia, 22/7/08

could be created for posts of all ages. Over an 8 hour period, 65-80% of chromium, 50-70% of copper and 75-90% of arsenic was extracted from all posts.

Given the excellent extraction observed under relatively simple nitric acid extraction, further studies on the applicability of nitric pulping for CCA remediation are recommended. Minimizing chip size subject to fibre size constraints in paper production is key to improved removal and additional means for enhancing chip surface area are identified. Other stages present in paper pulping process may solublize additional CCA and these warrant further investigation. A basic economic estimation was undertaken, where it was found that creating paper pulp from CCA wood could be economically feasible, but will require further research to determine the expected costs and revenues involved.

The nature of the CCA wood waste was investigated. The expectation was that CCA posts would contain relatively consistent concentration profiles for copper, chromium and arsenic. However, it was observed that the concentrations were quite varied. Further, several posts produced during the wine boom in South Australia were very poorly treated with very poor penetration of the preservatives into the posts. This could result in a reduced lifetime for the posts, and potentially higher arsenic leaching than expected. It is also recommended that the frequency of these poorly treated posts be determined, as three of the six posts examined from this period were potentially poorly treated, implying it may be significant and unexpected problem. In addition, a study should be initiated to determine if these poorly treated posts are leaching higher levels of arsenic, by both a study of the surrounding soil and a simulated rainfall leaching experiment.

Based on the concern that more arsenic leached from pieces of CCA post left in deionised water than expected, an experiment on posts of various ages revealed that over a 100 day period, 1.5-3g of elemental arsenic could leach from a submerged CCA treated post. There is a serious concern that with CCA posts being landfilled, they will be exposed to water contact over the wet months, resulting in high arsenic leaching. It is theorised that this high arsenic leaching is due to insufficient chromium in the CCA solution. Previous studies have recommended higher chromium to arsenic ratios than are currently employed in Australia. Further studies on the extent to which this leaching can occur in landfill are recommended.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Connell Wood and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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